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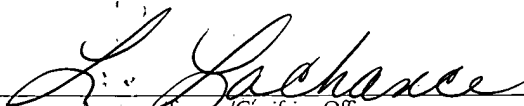
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Specification and Drawings, as originally filed, with Application for Patent Serial
No: **2,420,939**, on March 5, 2003, by **TIR SYSTEMS LTD**, for "Colour Wash
Illumination System Incorporating Light Emitting Diodes".


Agent certificateur/Certifying Officer
September 9, 2005

Date

Canada

(CIPO 68)
31-03-04

OPIC  CIPO

COLOUR WASH ILLUMINATION SYSTEM INCORPORATING LIGHT EMITTING DIODES

FIELD OF THE INVENTION

The present invention pertains to the field of illumination systems and in particular to a
5 colour wash illumination system incorporating light emitting diodes.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a colour wash illumination system
incorporating light emitting diodes. In accordance with an aspect of the present invention,
there is provided a light distribution system comprising: a plurality of illumination light
10 sources, said light sources being light emitting diodes providing illumination having a
plurality of wavelengths; a macroscopic optical system associated with each of said plurality
of illumination light sources providing control of distribution of the illumination provided by
the illumination light sources; a microscopic optical system for diffusing the illumination
after interaction with the macroscopic optical system such that a desired level of diffusion of
15 the illumination is achieved; and a power source for providing said illumination light sources
with energy.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1 is a schematic of the horizontal wash optics according to one embodiment of the
present invention.

20 Figure 2 is a schematic of the vertical wash optics according to one embodiment of the
present invention.

Figure 3 is a schematic of a short parabolic reflector according to one embodiment of the
25 invention.

Figure 4 is a schematic of light reflection by a reflector according to one embodiment of the present invention.

5 Figure 5 is a schematic of a trough parabolic reflector according to one embodiment of the present invention.

Figure 6 is a is a schematic of a middle reflector according to one embodiment of the present invention.

10 Figure 7 is a schematic of a vertical wash reflector assay according to one embodiment of the present invention.

Figure 8 is a polar graph of illumination using a system according to one embodiment of the present invention.

15 Figure 9 is a polar graph of illumination using a system according to one embodiment of the present invention.

Figure 10 is a graph of the horizontal illuminance using a system according to one
20 embodiment of the present invention.

Figure 11 is a graph of the spectral power distribution using a system according to one embodiment of the present invention.

25 Figure 12 is a graph of a comparison of wall illuminance using a system according to one embodiment of the present invention.

Figure 13 is a graph of specular vs diffuses mirrors vs rotation using a system according to one embodiment of the present invention.

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Figure 14 is a graph of the normalized illuminance using a system according to one embodiment of the present invention.

Figure 14 is a graph of the normalized illuminance using a system according to one embodiment of the present invention.

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DETAILED DESCRIPTION OF THE INVENTION

Definitions

The term "wash" is used to define the combination or blending of varying illumination light wavelengths such that these wavelengths may be combined to form a uniform colour or a graded colour distribution.

10

Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs.

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The present invention provides a colour wash system incorporating light emitting diodes (LED) wherein the colour of the illuminating light can be varied depending on the intensity of the illumination provided by a particular colour of LED. The colour wash system incorporates a plurality of LEDs of varying colours, for example a collection of red, green and blue LEDs can enable the creation of an illumination colour wash representative of a colour in the visual spectrum in addition to "white" light. For example the LEDs incorporated into the system can be a collection of red, green and blue LEDs.

20

The system comprises a plurality of LED emitters and a combination of both microscopic and macroscopic lenses. The outcome is a controlled distribution of light that achieves a uniformly illuminated target surface. Two different configurations of optics are defined wherein one configuration enables the horizontal washing of the illumination light and the second configuration enables the vertical washing of the illumination light. These optical configurations can be provided individually or in combination, wherein in combination a vertical and horizontal wash of the illumination light may be provided.

25

Horizontal Wash Optics

With reference to Figure 1, the horizontal wash optics incorporate macroscopic optics and microscopic optics in order to provide the horizontal wash of the illumination sources or varying colours. These macroscopic optics are associated with each of the illumination light sources or LEDs in order to provide the desired affect.

The macroscopic optics incorporate primary optics, for example a plastic injection molded lens that used total internal reflection, in order to achieve a portion of the lambertian or uniform spread of the illumination light. In addition a plurality of secondary optics, for example specular flat mirrors can be incorporated in order to complement the lambertian spreading of the primary optics.

The microscopic optic incorporate a tertiary optic, which defines the last optical path prior to the light rays being delivered to the work plane. The microscopic optics can be a uniform optical diffuser which enables the tailoring of the light distribution. This diffuser can reduce the intensity of the LED sources by for example, eliminating the hot spots. This diffuser can be selected to achieve optimal beam pattern and consistent colour mixing of the of the different light wavelengths emitted by the LEDs.

Vertical Wash Optics

With reference to Figure 2, the vertical wash optics incorporate macroscopic optics and microscopic optics in order to provide the vertical wash of the illumination sources or varying colours. These macroscopic optics are associated with each of the illumination light sources or LEDs in order to provide the desired affect.

The macroscopic optics incorporate parabolic shaped mirrors that are capable of accurately controlling the aim, for example throw direction, of the light emitted by the plurality of LED point sources. The positioning of the parabolic shaped mirrors or reflectors can be very important in order to achieve a desired distribution of the illumination light from the LED light sources.

The microscopic optics comprise a lateral optical diffuser which can enable the selective mixing of the illumination light in only the horizontal direction. The microscopic optics can provide an ability to control the amount of diffusion enabling a desired mix of the
5 illumination wavelengths of light being supplied by the LED light sources. For example this diffuser enables the appropriate mixing of the colours red, green and blue.

The embodiments of the invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit
10 and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

**THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE
PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:**

1. A light distribution system comprising:

- 5 a) a plurality of illumination light sources, said light sources being light emitting diodes providing illumination having a plurality of wavelengths;
- b) a macroscopic optical system associated with each of said plurality of illumination light sources providing control of distribution of the illumination provided by the illumination light sources;
- 10 c) a microscopic optical system for diffusing the illumination after interaction with the macroscopic optical system such that a desired level of diffusion of the illumination is achieved; and
- d) a power source for providing said illumination light sources with energy.

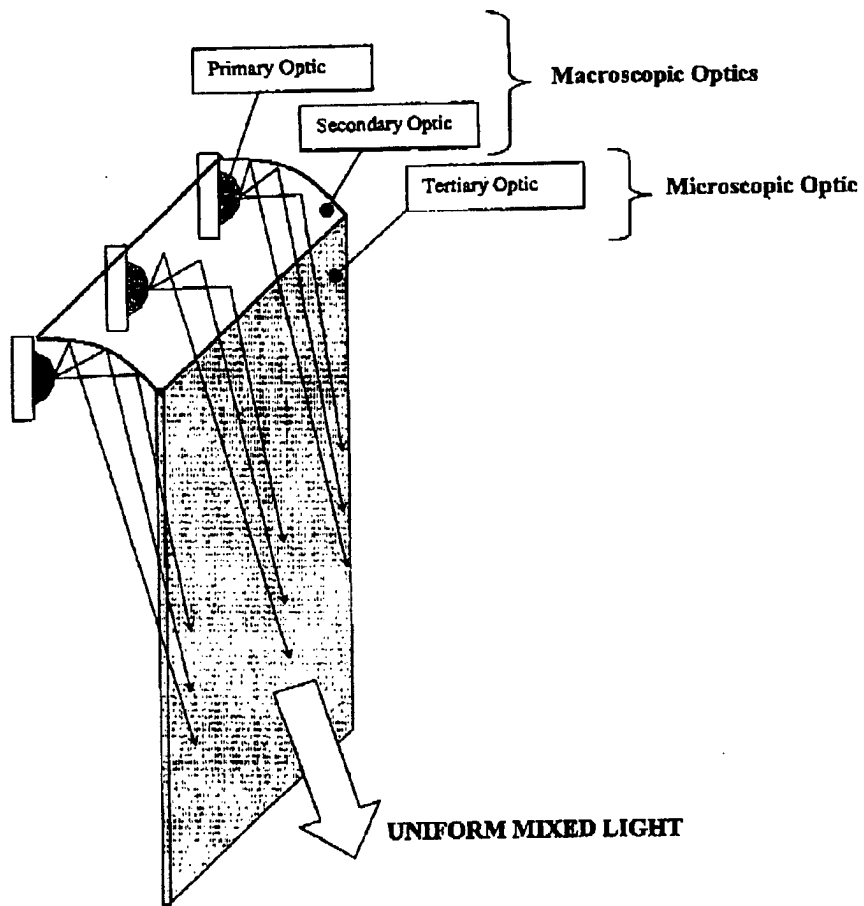
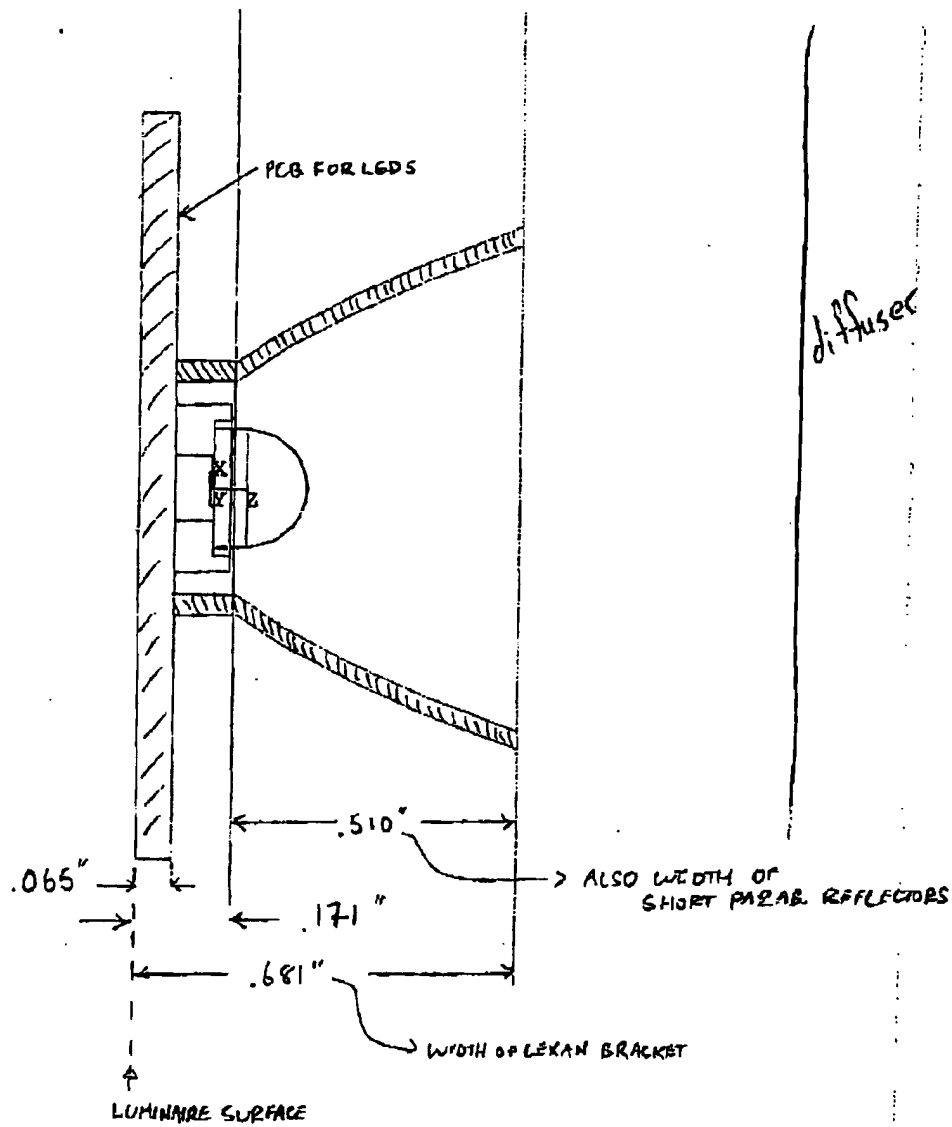


FIG 1

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FIG 3

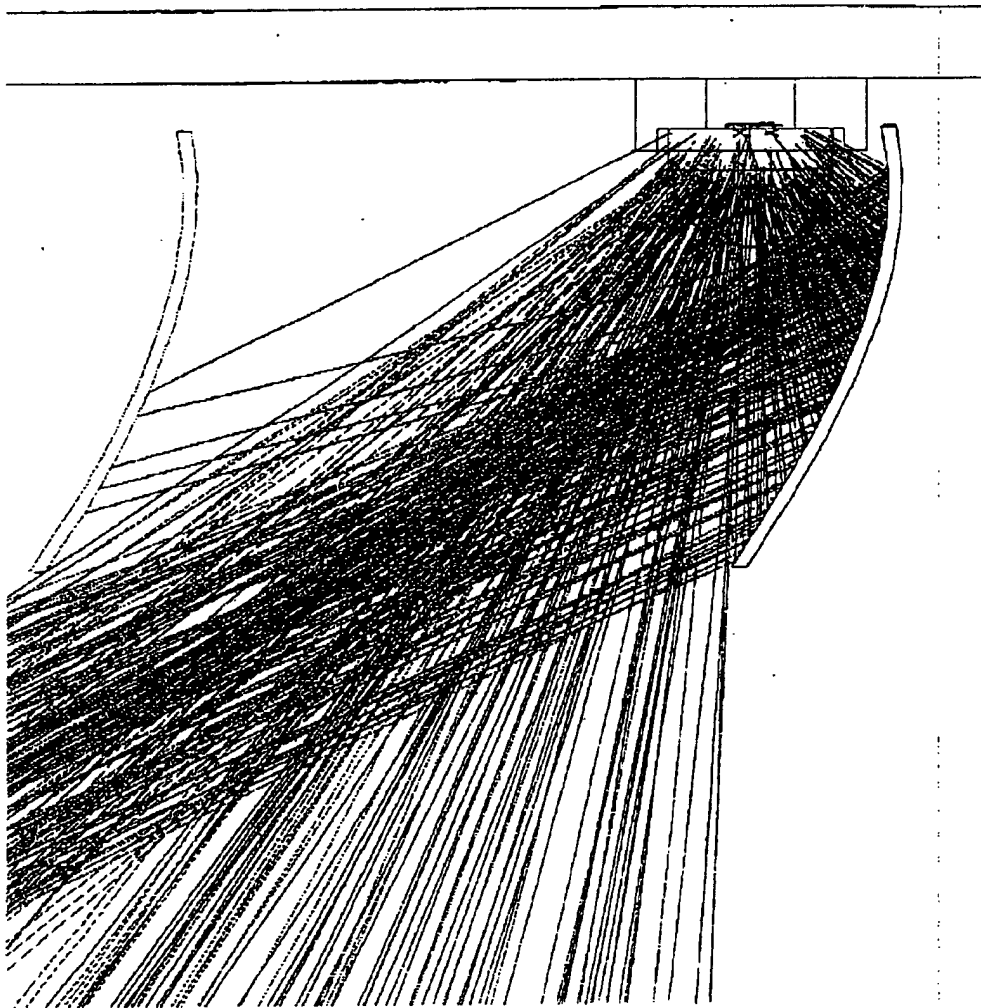
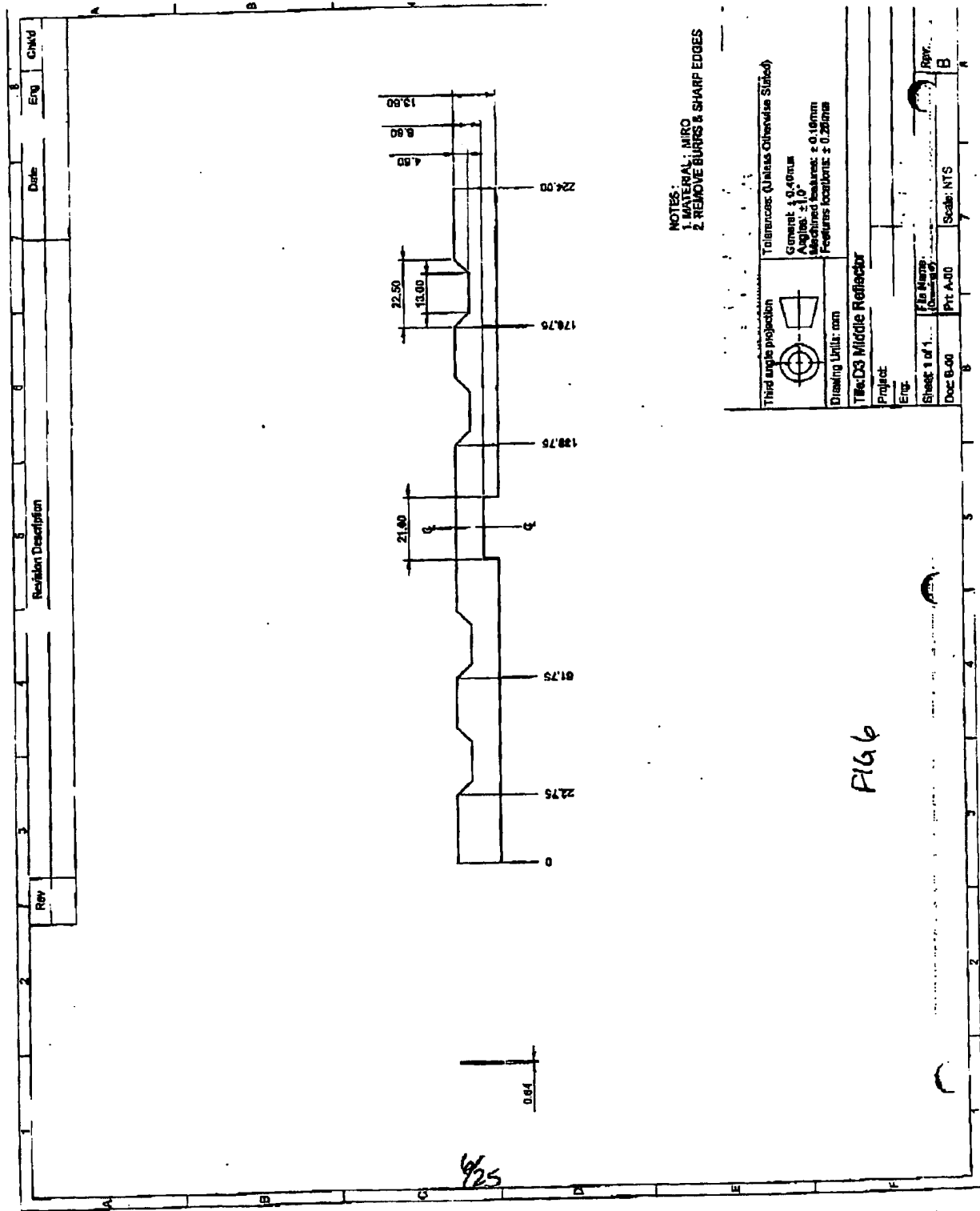


FIG 4

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NOTES:

1. MATERIAL: 0.030" THICK 6061 ALUMINUM
2. REMOVE BURRS & SHARP EDGES
3. REFLECTIVE SURFACE MUST BE FREE FROM SCRATCHES AND BLEMISHES
4. LEAVE PROTECTIVE FILM ON REFLECTIVE SIDE UNTIL ASSEMBLY IN PRODUCT

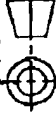


NOTES:
1. MATERIAL: NIRO
2. REMOVE BURRS & SHARP EDGES

Tolerances: (Unless Otherwise Stated)

General: $\pm 0.40\text{mm}$
Asplied: ± 0.10
Machined features: $\pm 0.10\text{mm}$
Feature locations: $\pm 0.25\text{mm}$

Third angle projection



Drawing Unit: mm

Title: D3 Middle Reflector

Project:

Eng:

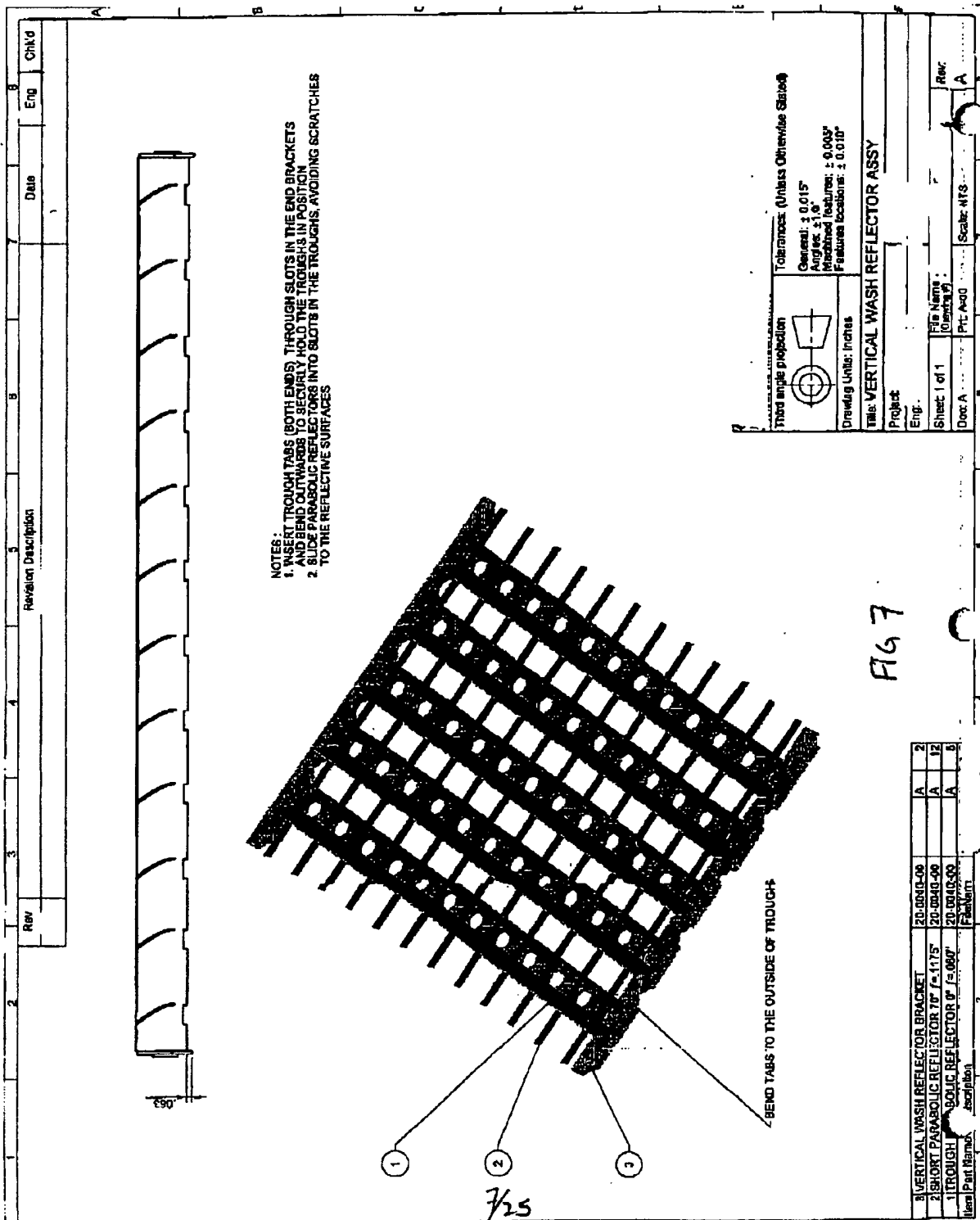
Sheet 1 of 1

Date: 0-00

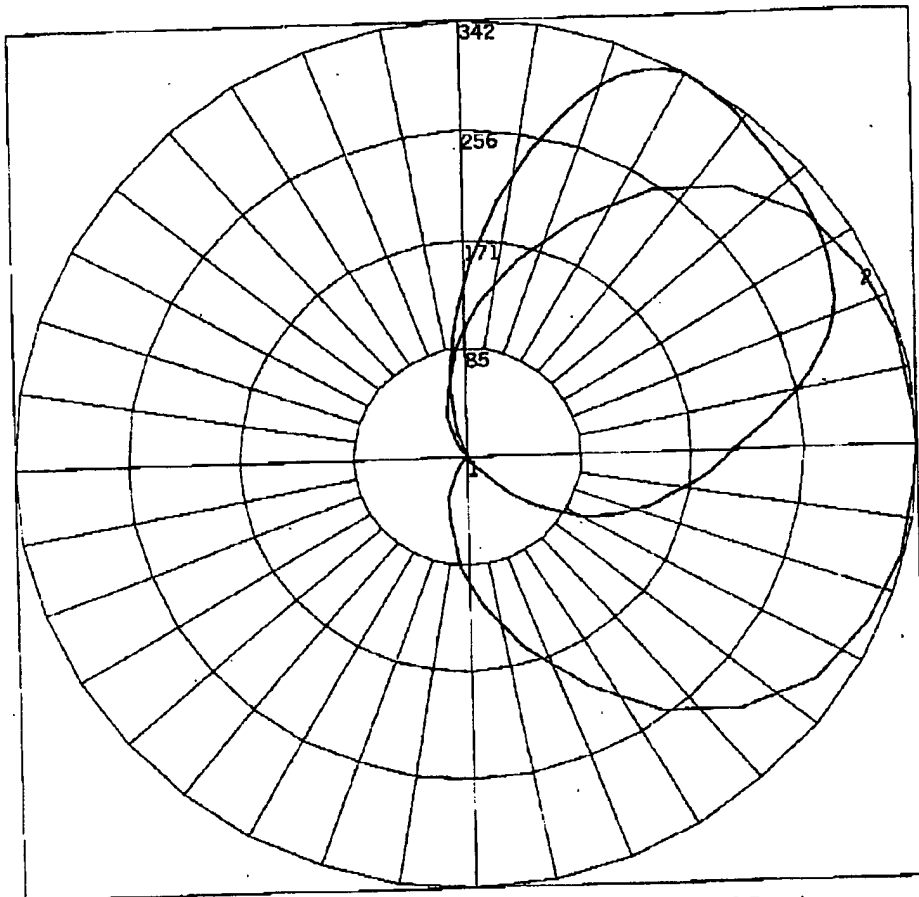
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Scale: NYS

Rev: B



POLAR GRAPH



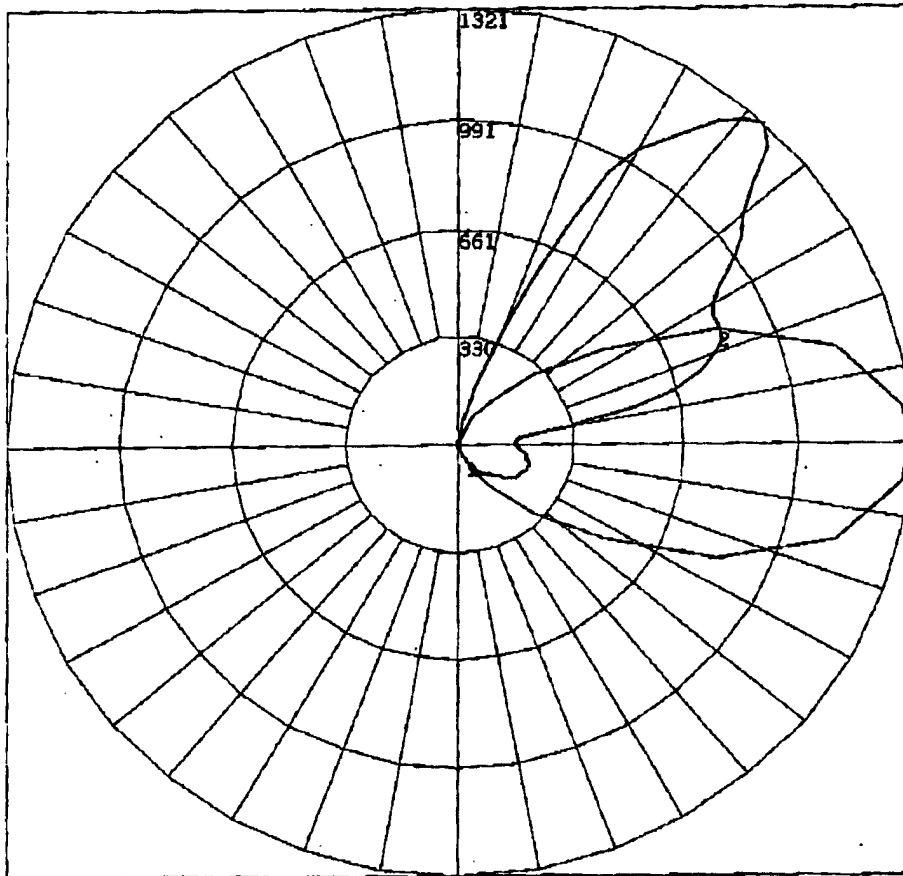
Maximum Candela = 341.5 Located At Horizontal Angle = 0, Vertical Angle = 147.5
 # 1 - Vertical Plane Through Horizontal Angles (0 - 180) (Through Max. Cd.)
 # 2 - Horizontal Cone Through Vertical Angle (147.5) (Through Max. Cd.)

horizontal work opti

FIG 8

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POLAR GRAPH



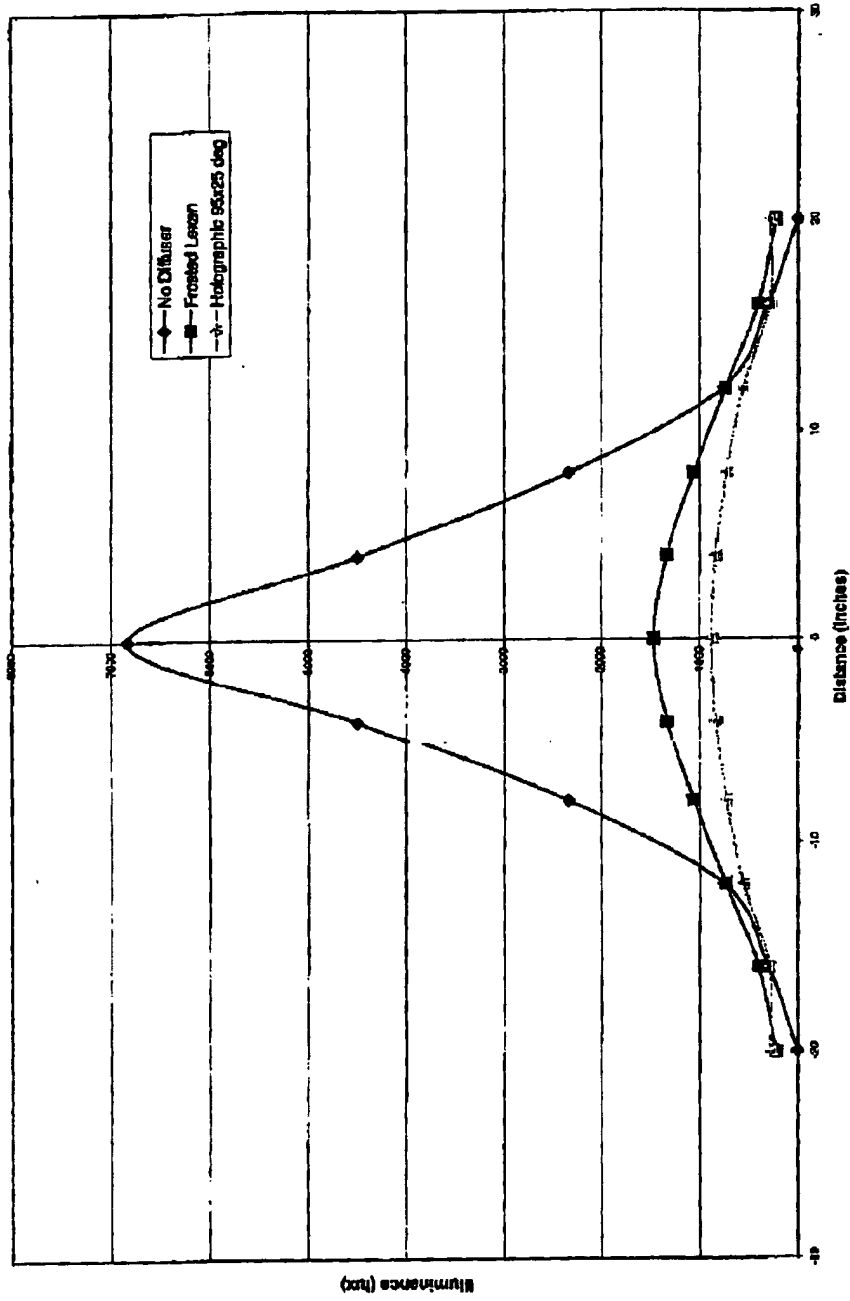
Maximum Candela = 1321 Located At Horizontal Angle = 0. Vertical Angle = 137.5
 # 1 - Vertical Plane Through Horizontal Angles (0 - 180) (Through Max. Cd.)
 # 2 - Horizontal Cone Through Vertical Angle (137.5) (Through Max. Cd.)

vertical ward optic

FIG 9

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Horizontal Illuminance (4' away from LED's)



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Spectral Power Distribution of RGB Mixing using DCW

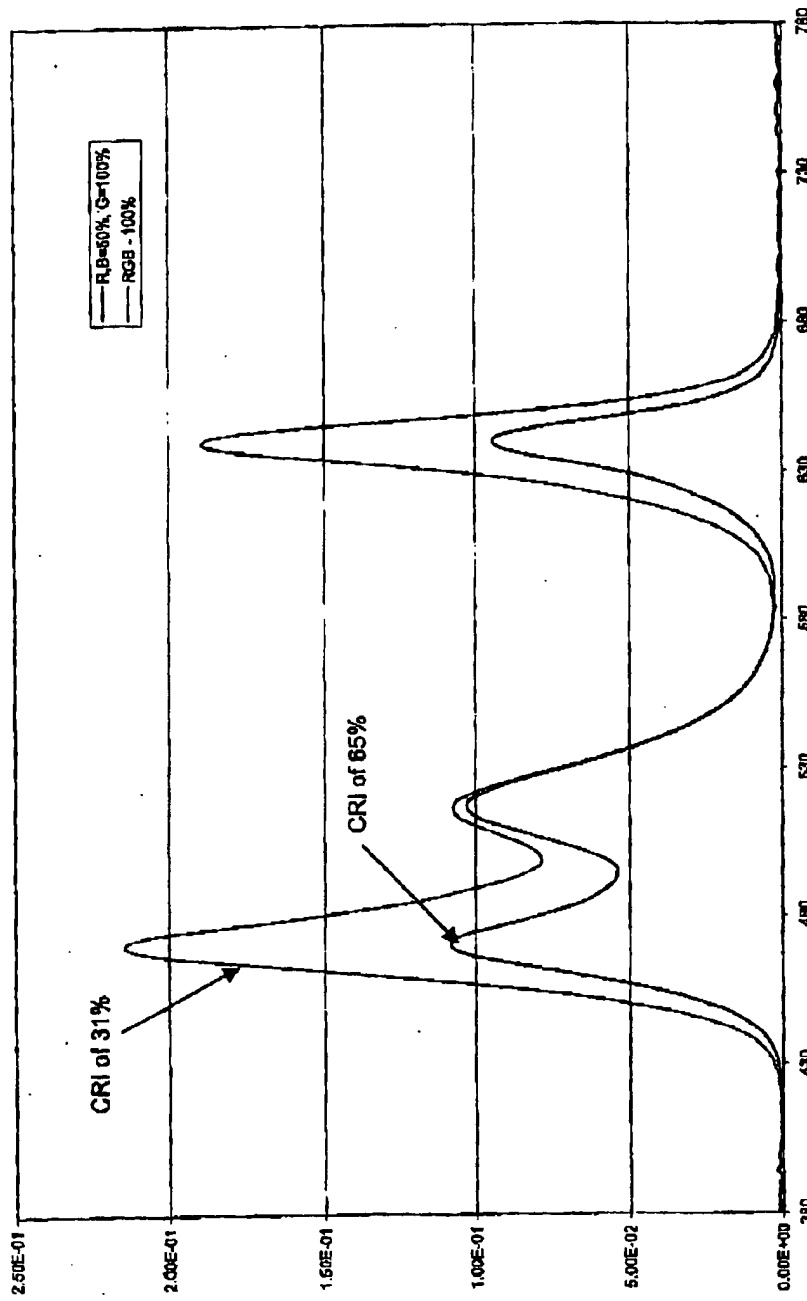
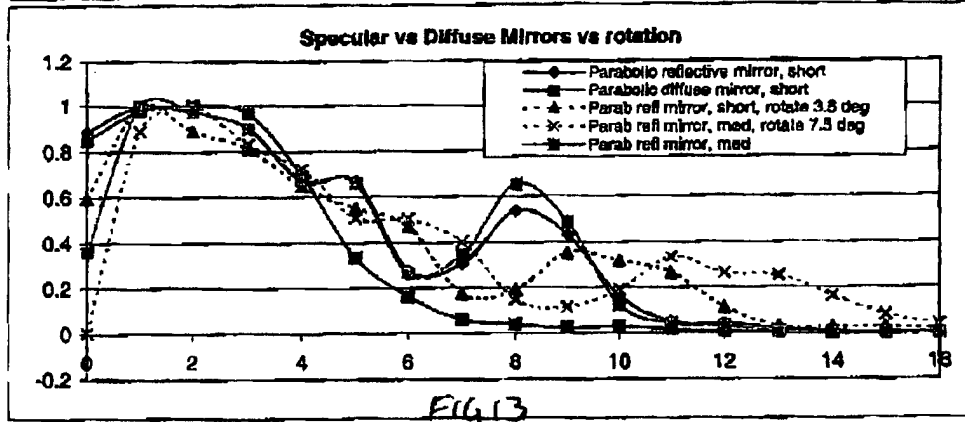
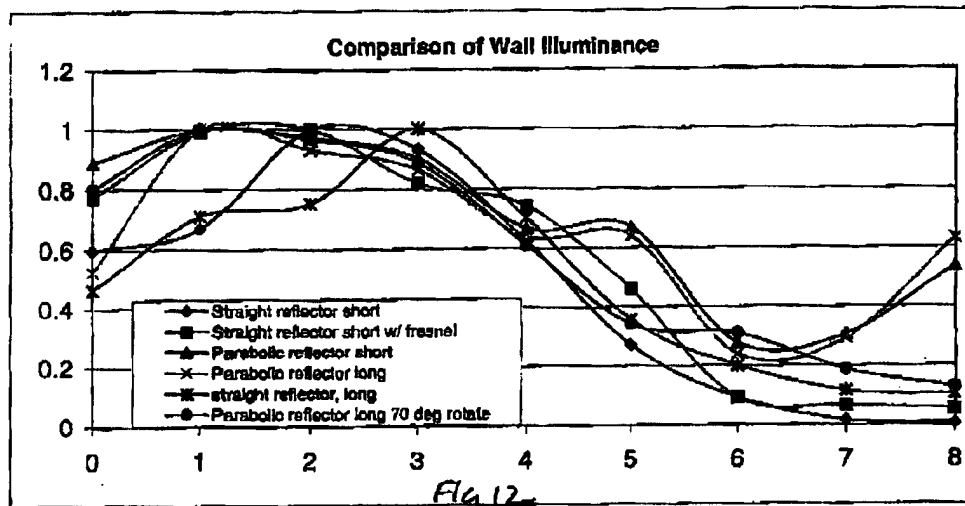
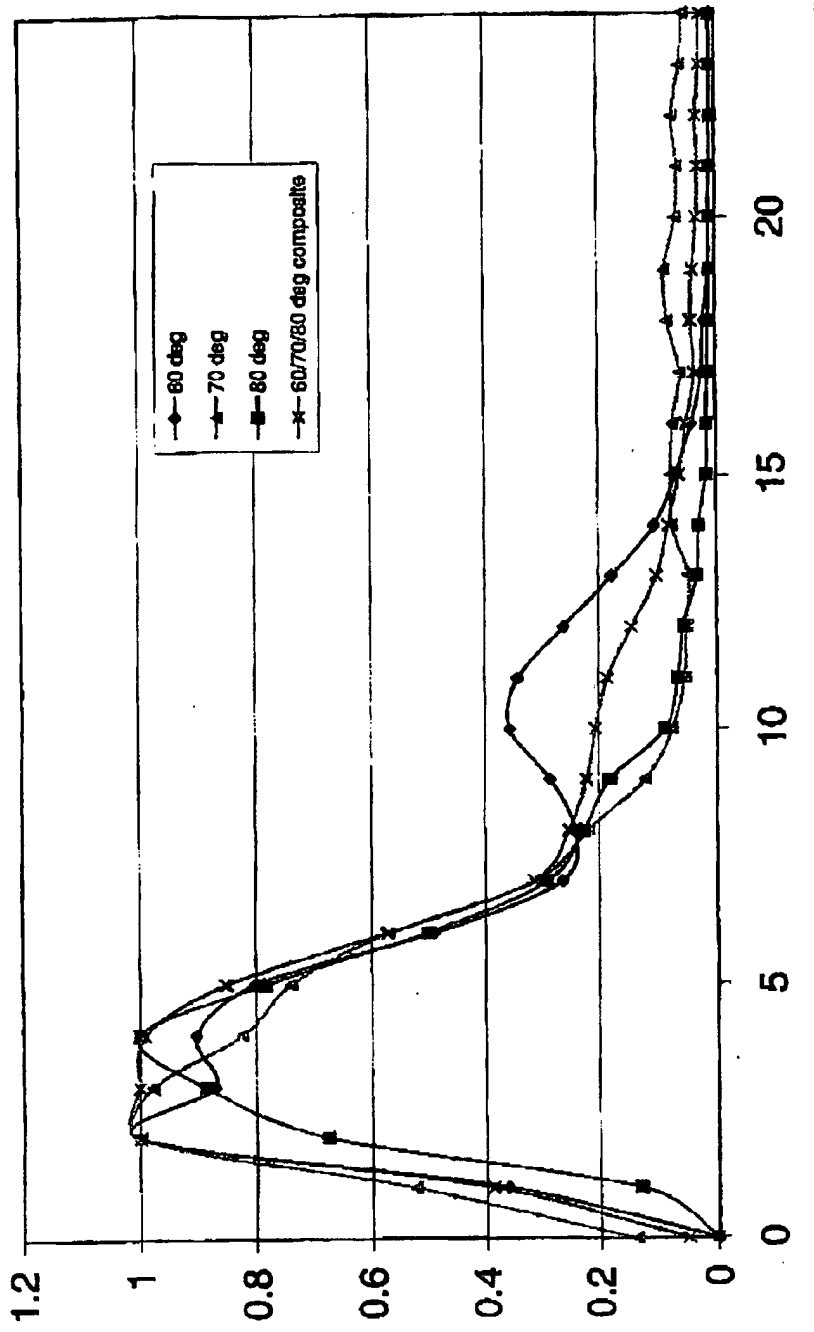


FIG 11



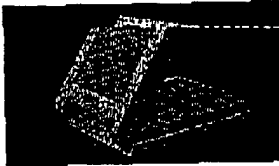
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Normalized Illuminance - sum of short + long reflectors



Fla 14

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standard specifications	OPTICS	Vertical Wash Optic <i>and/or horizontal wash optic</i>
	LIGHT SOURCE	60 Lumileds Luxeon High Flux LED's
	DISTRIBUTION	Asymmetric forward throw
	LED LIGHT COLOR	60 Multiple Color LED's: 12 Red, 24 Green, and 24 Blue for color changing and mixing
	FINISH	3 standard paint finishes: Black, Silver or White
	POWER SUPPLY	120VAC Integral Power Supply and Wiring Box

FIG 15a

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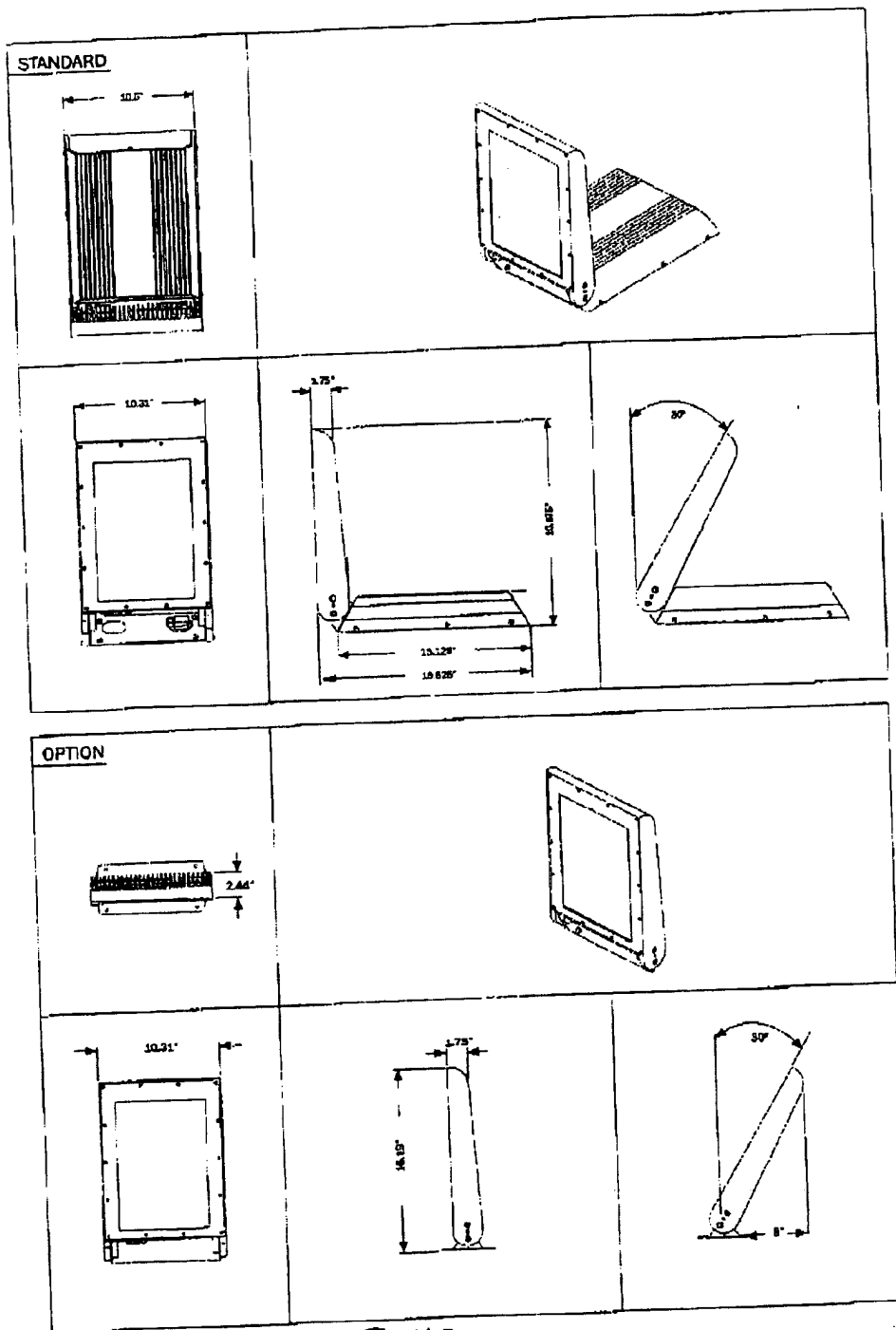


FIG 13B

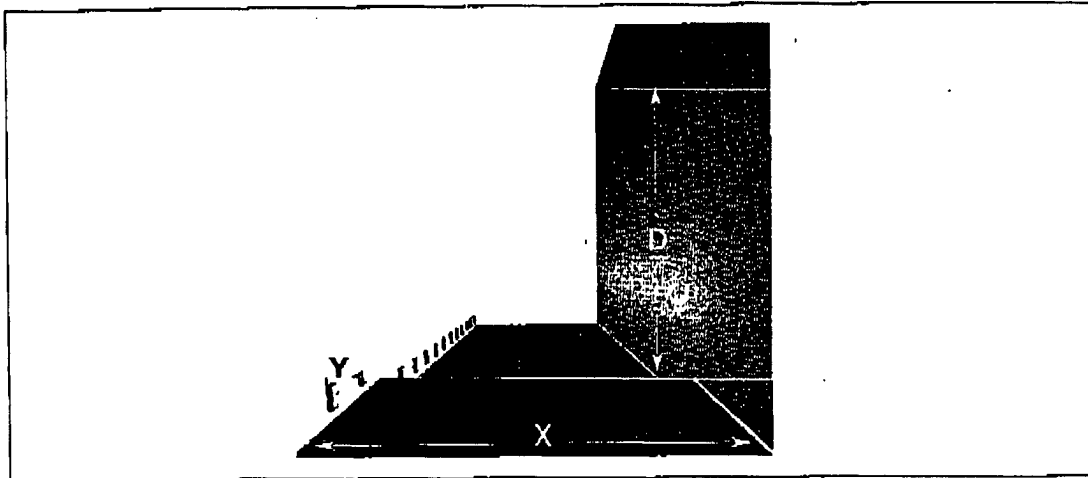
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technical specifications	mechanical	HOUSING (BASE & HEAD)	Die-cast aluminum			
		MOUNTING	Wall, Ceiling or Floor mount; maximum tilt +30°/-90°			
	electrical	INPUT VOLTAGE	120VAC standard			
		MAX INPUT POWER	MODEL	OUTPUT COLOR (ON FULL)	LUMINAIRE INPUT POWER	INPUT CURRENT
			Standard model	Red	19.2W	0.28A
			Standard model	Green	43.4W	0.65A
			Standard model	Blue	43.4W	0.65A
			Standard model	White	106W	1.60A
		Single Color option	Green or Blue	108.5W	1.45A	
		Single Color option	Red or Amber	75.3W	1.64A	
environmental	CONNECTIONS	Separate Power & Data: Power: Standard 120VAC connection Data: 1 Pair + GWD, 22 AWG, Standard connection for DMX512; may be daisy chained				
	TEMPERATURE RANGE	-40°F to 122°F (-40°C to 50°C) operating temperature -4°F to 122°F (-20°C to 50°C) starting temperature				
	CERTIFICATION	UL/CUL				
	INGRESS PROTECTION	IP66 Rated				

photometrics	application	OPTIC TYPE	PLACEMENT RATIO		RECOMMENDED PLACEMENT
		VERTICAL WASH OPTIC	Maximum Setback Ratio		4.5:1
	color comparison chart		Maximum Spacing Ratio		1:1
		COLOR	VERTICAL WASH AVERAGE ILLUMINANCE (FC)	DESTINY COLORWASH LED POWER (WATTS)	ENVIRONMENTAL HALIDE SOURCE WITH COLOR FILTER* TO ACHIEVE PEAK WAVELENGTH
		RED	2.1	12.6	250W with 4% (HT027 MED RED)
		GREEN	3.0	29.4	100w with 11% (HT090 DARK YELLOW GRN)
		BLUE	0.7	29.4	100W with 3% (HT119 DARK BLUE)
		SETBACK RATIO	X = 4 FT		
		THROW DISTANCE	D = 18 FT		
		LUMINAIRE SPACING	Y = 4 FT		*Rosco Color Gels

FIG 15C

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illumination distribution	4'0.C.					18'0.C.
	2	2	2	2	2	
	2	2	2	2	2	
	3	3	3	3	3	
	3	3	3	3	3	
	4	4	4	4	4	
	5	5	5	5	5	
	6	6	6	6	6	
	7	8	7	7	7	
	9	9	9	9	9	
	11	11	11	11	11	
	13	13	13	13	13	
	16	15	15	15	15	
	19	18	18	18	18	
	23	24	22	23	23	
	27	24	24	25	26	
	24	18	19	22	23	
	17	11	13	15	18	
	12	10	9	10	11	
	12	11	10	10	12	

parameters	Setback Distance	X = 4 FT
	Throw Distance	D = 18 FT
	Luminaire Spacing	Y = 4 FT
	Units	Footcandles (Lux= footcandles x 10.76)
	Measured on	White (RGB on full)
Placement	Bottom of Grid at 15° tilt angle	

ILLUMINANCE			ILLUMINANCE MULTIPLIER		
Avg	Max:min	Max:avg	Red	Green	Blue
10.7	13.5	2.5	0.359	0.524	0.117

Candle Distribution for Direct ColorWash with Vertical Wash Optics (90° along vertical axis)

FIG 15D

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**Candela Distribution for
Destiny ColorWash with Vertical Wash Optic
(0 deg vertical head tilt)**

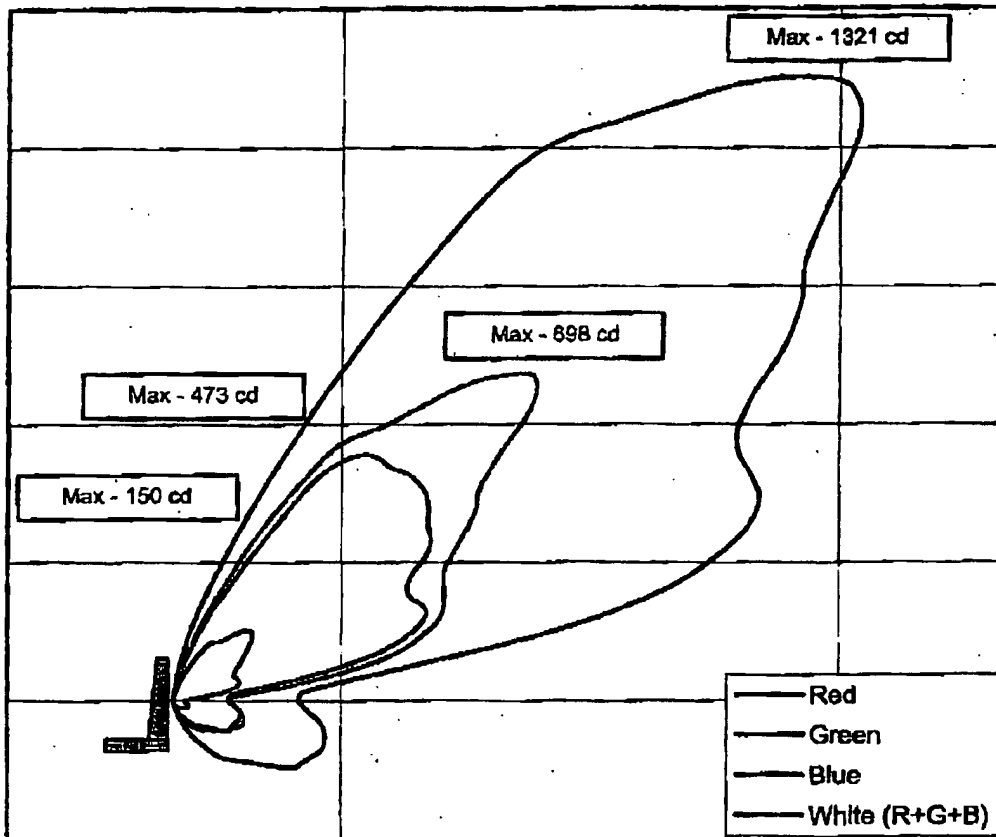


FIG 15E

18/
725

technical specifications	mechanical	HOUSING (BASE & HEAD)	Die-cast aluminum			
		MOUNTING	Wall, Ceiling or Floor mount; maximum tilt +30°/-90°			
	electrical	INPUT VOLTAGE	120VAC standard			
		MAX INPUT POWER	MODEL	OUTPUT COLOR (ON FULL)	LUMINAIRE INPUT POWER	INPUT CURRENT
		Standard model	Red	19.2W	0.29A	
		Standard model	Green	43.4W	0.65A	
		Standard model	Blue	43.4W	0.65A	
	environmental	CONNECTIONS	Standard model	White	106W	1.60A
			Single Color option	Green or Blue	108.5W	1.45A
			Single Color option	Red or Amber	75.3W	1.84A
Separate Power & Data: Power: Standard 120VAC connection Data: 1 Pair + GND, 22 AWG, Standard connection for DMX512; may be daisy chained						
TEMPERATURE RANGE			-40°F to 122°F (-40°C to 50°C) operating temperature -4°F to 122°F (-20°C to 50°C) starting temperature			
environmental	CERTIFICATION	UL/CUL				
	INGRESS PROTECTION	IP66 Rated				

photometrics	application	OPTIC TYPE	PLACEMENT RATIO		RECOMMENDED PLACEMENT
		HORIZONTAL WASH OPTIC	Maximum Setback Ratio		2.75:1
	color comparison chart		Maximum Spacing Ratio		2:1
		COLOR	HORIZONTAL WASH AVERAGE ILLUMINANCE (FC)	DESTINY COLORWASH LED POWER (WATTS)	ENVIRONMENTAL HALIDE SOURCE WITH COLOR FILTER* TO ACHIEVE PEAK WAVELENGTH
		RED	2.7	12.6	250W with 4% (HT027 MED RED)
		GREEN	3.3	29.4	100W with 11% (HT090 DARK YELLOW GRN)
		BLUE	0.9	29.4	100W with 3% (HT119 DARK BLUE)
		SETBACK DISTANCE	X = 4 FT		
		THROW DISTANCE	D = 11 FT		
		LUMINAIRE SPACING	Y = 8 FT		*Rosco Color Gels

FIG 15 F

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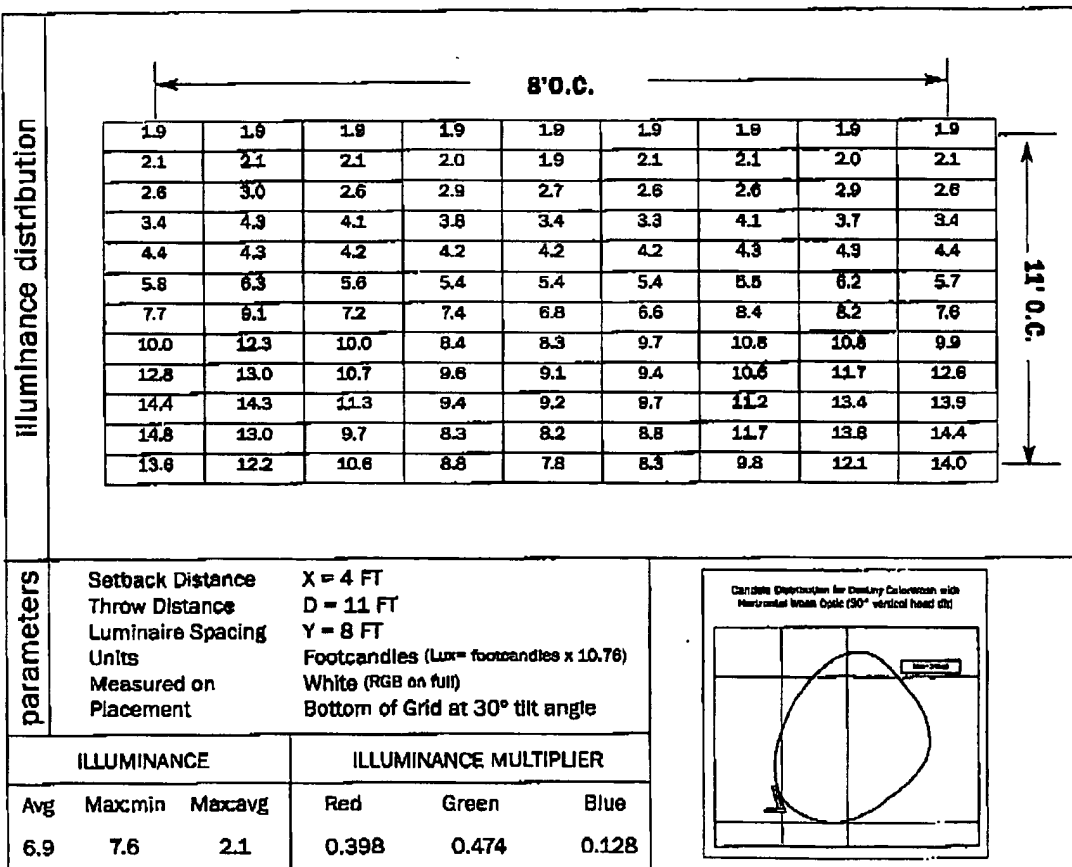
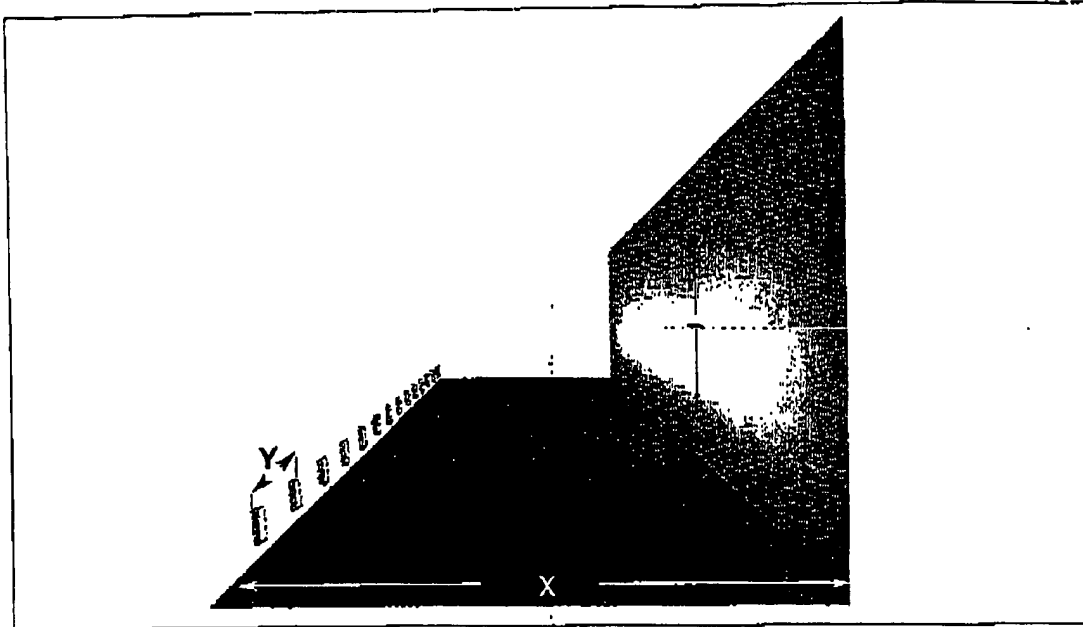


FIG 156

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**Candela Distribution for
Destiny ColorWash with Horizontal Wash Optic
(30 deg vertical head tilt)**

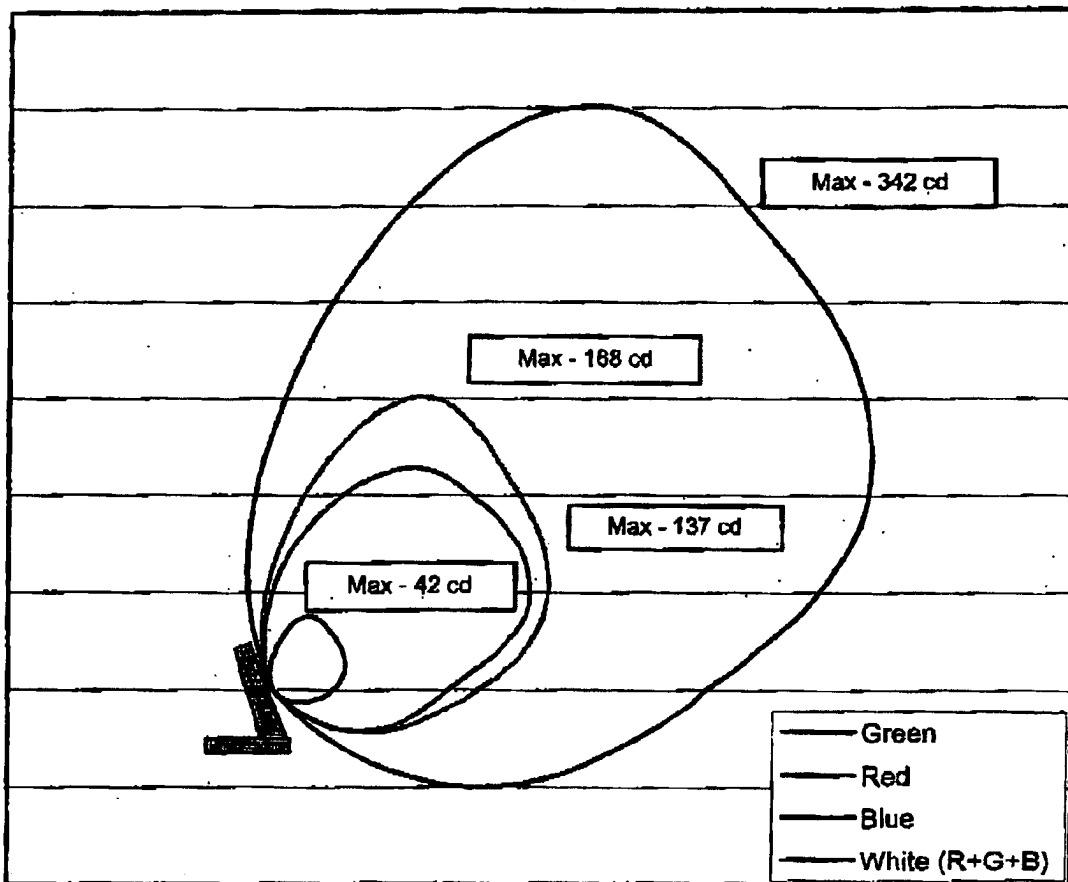


FIG 15 H

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mounting details: standard mount	PRODUCT CONFIGURATION	The luminaire head is connected to the base. Wiring egress (for power and data) is at the bottom of the base.
	APPLICATION	For mounting on walls, floors, ceilings, or stanchions; the junction box(es) is (are) located under the luminaire base (e.g. if wall mounted, the j-box(es) would be recessed in the wall).
	INSTALLATION	<ol style="list-style-type: none"> 1. Remove base bracket from base: Remove the base locking screws and track mounting screws to remove the base bracket from the base. 2. Mount the base bracket: Attach the base bracket, over the flush mounted junction box, to the mounting surface. 3. Slide the base onto the bracket: Re-insert the two side base locking screws half way in (located on each side of the base, closest to the head). Slide the base onto the bracket, until the base rests on the two base locking screws. 4. Make the wire connections: Connect the power cable leads into the recessed junction box in accordance with local electrical regulations. Connect the DMX cable with waterproof 3M Scotch-Loc UR connectors and crimp them for water proof seal. There should be one j-box for power and one j-box for DMX, or a divided j-box. (See Electrical Connections for more details.) 5. Close the luminaire: Remove the two side base locking screws and slide the luminaire in position. Tighten the four track mounting screws. Lock the luminaire with the two side base locking side screws and the third base locking screw. 6. Seal luminaire: seal the luminaire with caulking appropriate for specific surface type. 7. Adjust Head: adjust the tilt angle of the head as desired, and lock the pivot locking screws.

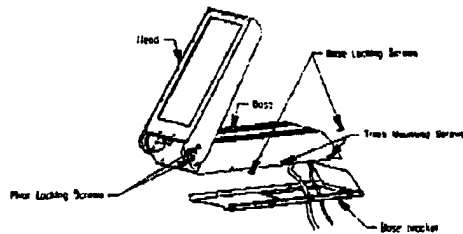
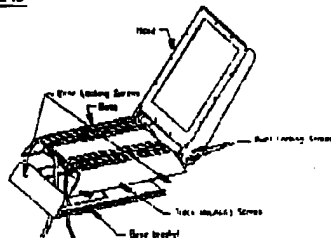
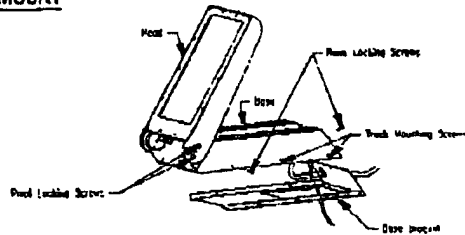
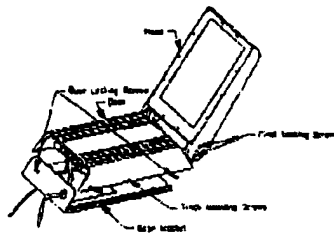
INTEGRAL BASE AND HEAD**INTEGRAL BASE WITH REVERSE HEAD**

FIG 151

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mounting details: surface mount	CONFIGURATION	is at the side of the base.
	APPLICATION	For mounting on walls, floors, ceilings, or stanchions; the junction box(es) located under the luminaire base (e.g. for a retrofit application that is wall mounted, the j-box for power would be located on the surface).
	INSTALLATION	<ol style="list-style-type: none"> 1. Remove base bracket from base: Remove the base locking screws and track mounting screws to remove the base bracket from the base. 2. Mount the base bracket: Attach the base bracket to the mounting surface. 3. Slide the base onto the bracket: Re-insert the two side base locking screws half way in (located on each side of the base, closest to the head). Slide the base onto the bracket, until the base rests on the two base locking screws. 4. Make the wire connections: Connect the power cable leads into the surface mount junction box in accordance with local electrical regulations. Drill a hole through the surface base bracket opening, to run the DMX cable through it. Connect the DMX cable with waterproof 3M Scotch-Loc UR connectors and crimp them for water proof seal. (See Electrical Connections for more details.) 5. Close the luminaire: Remove the two side base locking screws and slide the luminaire in position. Tighten the four track mounting screws. Lock the luminaire with the two side base locking side screws and the third base locking screw. 6. Seal luminaire: seal the luminaire with caulking appropriate for specific surface type. 7. Adjust Head: adjust the tilt angle of the head as desired, and lock the pivot locking screws.

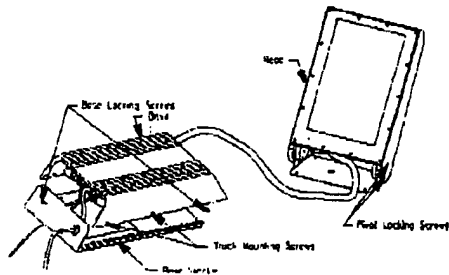
INTEGRAL BASE SURFACE MOUNT**INTEGRAL BASE SURFACE MOUNT WITH REVERSE HEAD**

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mounting details: remote mount	PRODUCT CONFIGURATION	The luminaire head is connected to the base with a long cable (10', 15', or 20' cable depending on the selected configuration). The head unit comes with a pivot mounting bracket. The base wiring egress (for power and data) is at the side of the base.
	APPLICATION	For mounting on walls, floors, ceilings, or stanchions; where space limitation (or visual preference) requires that the head is mounted at a distance away from the base (e.g. the base is mounted in a convenient hidden location).
	INSTALLATION (Mount the base)	<ol style="list-style-type: none"> 1. Remove base bracket from base: Remove the base locking screws and track mounting screws to remove the base bracket from the base. 2. Mount the base bracket: Attach the base bracket to the mounting surface. 3. Slide the base onto the bracket: Re-insert the two side base locking screws half way in (located on each side of the base, closest to the head). Slide the base onto the bracket, until the base rests on the two base locking screws. 4. Make the wire connections: Connect the power cable leads into the surface mount junction box in accordance with local electrical regulations. Drill a hole through the surface base bracket opening, to run the DMX cable through it. Connect the DMX cable with waterproof 3M Scotch-Loc UR connectors and crimp them for water proof seal. (See Electrical Connections for more details.) 5. Close the luminaire: Remove the two side base locking screws and slide the luminaire in position. Tighten the four track mounting screws. Lock the luminaire with the two side base locking side screws and the third base locking screw. 6. Seal luminaire: seal the luminaire with caulking appropriate for specific surface type.
	(Mount the head)	<ol style="list-style-type: none"> 1. Mount the pivot bracket: Install 4 anchors to the mounting surface and mount the pivot bracket. 2. Install Head: Install the head to the pivot bracket and adjust the tilt angle as desired, and lock the pivot locking screws. 3. Connect to base: Connect the head cable to the base with the waterproof connector supplied on the cable.

REMOTE BASE WITH 10', 15', OR 20' CABLE



FLG15K

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electrical connection	POWER	Supply 120 volts AC to the BLACK jacketed power cord, or conduit, of the luminaire base. Make connections in a recessed or surface mounted junction box in accordance with the local electrical regulations.
	DATA CABLE	To be connected using methods appropriate to 12 volt DC circuits. When making connections in the luminaire base use 3M Scotch-Loc waterproof connectors.
	INSTALLATION	<p>Individual Luminaires are to be connected to an appropriate DMX control device by means of a small diameter RED jacketed 3-wire data cable. The outer jacket is stripped back revealing a black wire, white wire and bare wire. The black wire is for Data -, the white wire is for Data +, and the bare wire is the 0 volt (GND) reference.</p> <p>Connection of Multiple Luminaires to be completed according to the USITT DMX512 standard for DMX512 networks. The DMX controller is to be connected to a series of luminaires which are daisy-chained together in a single run with each luminaire acting as a full load. It may be necessary to use signal amplifiers (repeaters) after 1600 ft (500 m).</p>

FIG 15L

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